PROCESS AND APPARATUS FOR MANUFACTURING SET CELLULAR CEMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority of EP 04290494.6, filed on Feb. 24, 2004, the subject matter of which is incorporated herein by reference.

FIELD OF THE INVENTION

The instant invention relates to a process and an apparatus for manufacturing cellular cementitious slurry and the set material obtained therefrom. The invention also relates to processes and apparatuses incorporating the instant process. The instant invention refers in the first place to the manufacture of plasterboard and more specifically to the manufacture of a plasterboard core on continuous plasterboard lines.

DESCRIPTION OF RELATED ART

Cementitious materials are known for many years. Examples of cementitious material can be gypsum (which is available in many forms), Portland cement, sorrel cement, slag cement, fly ash cement, calcium alumina cement, and the like.

Plasterboard consists, grossly speaking, of two sheets of a material having a certain tensile strength, like paper, covering a core, essentially of cement generally gypsum, with a certain compressive strength. The flexural strength of composite material depends upon the combined strengths of the components.

One element influencing the strength of the core is the water/plaster ratio used for the preparation. A rule of thumb is that the compression strength of a cast gypsum body increases with the square of its apparent density. In the range of application the density increases nearly linearly with the inverse of the W/P ratio. Thus, a low W/P ratio is traditionally considered as favorable.

The core of plaster wallboard is usually lightened by incorporation of air into the core preparation. The air in the core appears in the form of bubbles. It has been found that the size and the distribution of the bubbles have influence on the mechanical properties of the core and therefore of the board. A broad size distribution of bubble diameter and evenly scattered over the bulk are favorable. A layer of dense material, without or with fewer voids, near an optional covering is favorable. In that respect, one may revert to U.S. Pat. Nos. 5,085,929 and 5,116,671 to Bruce, hereby incorporated by reference.

The air is usually introduced into the plaster slurry in the form of prefabricated foam. In the normal foam generation systems, a quantity of foam-generating surfactant is diluted with water and then combined with compressed air. Foam is generated using various devices and processes. This foam is injected into the mixer, usually directly in the mixer. The mixer, which is usually a high shear mixer, assures the foam is completely combined with the plaster slurry but at the cost of a huge reduction in foam efficiency. The volume of foam added to the slurry is typically 3 times the volume actually combined in the board. Therefore, in accordance with the classical prior art, part of the gauging water for the plaster is added with the foam. More water in the foam raises the density of the foam and allows more uniform mixing with the plaster slurry, which is of higher density than the foam. However, this additional water reduces the final strength of the gypsum matrix by unnecessarily increasing the space between the gypsum crystals and, thus, forming a weaker structure.

U.S. Pat. No. 5,575,844 to Bradshaw discloses a secondary mixer (mounted in the same casing), in which the foam is introduced, while water and plaster are introduced in the primary mixer. The first mixer is for plaster and water while the second is for foam addition, where the shear is lower.

U.S. Pat. No. 5,714,032 to Ainsley discloses a two-chamber mixer, comprising a first, high-shear, chamber and a second, low-shear, chamber in which the foam is introduced.

U.S. Pat. No. 5,683,635 to Sucech discloses a process in which the foam is inserted into the slurry at a point where it is less agitated than during the creation of the slurry in the first mixer, whereby the foam is less agitated than if inserted in the pin mixer itself.

While these documents provide processes with lower foam consumption, additional water is still combined with the foam to the detriment of the final gypsum core properties.

Further, these documents disclose processes that still provide the usual pore volume with no control over the size and distribution of the bubbles.

Direct air injection during the creation of the cementitious slurry is also known.

U.S. Pat. No. 6,443,258 to Putt discloses a process for making sound absorbing panels in which plaster, fibers, water and foaming agent are mixed and simultaneously aerated using a mixing device similar to a kitchen aide mixer, orbiting and rotating mixing device. Air is entrapped, from the ambient, in the slurry, where the entrapment results from the combination of a dry mixture of plaster, (and optional additives) and of an aqueous mixture of water and surfactant.

DE-A-2,117,000 to Anton discloses a mixer for producing wall-finishing mortar. The apparatus can be worked according to two embodiments. In the first one, air is forced in a flow of gauging water, where said water has been through a cartridge filled with a surfactant. What is introduced in the mortar mixer is actually foam (pressurized foam). In the second embodiment, no surfactant is mentioned. Air is introduced in the slurry through a porous fritted glass member, at a level of the mixing screw of the unique mixer that is used. The type of mixer used in this document is not suited for the production of boards or panels, since the slurry that is produced is of high viscosity so as to adhere to the wall, making this slurry completely unsuited for the conventional production of boards or panels. Last, this type of mixer presents the drawback of a lot of air loss. This design presents the fatal flaw of being a pump of constant volume and with no control of share of air entering the pump. This causes a variation in the water to plaster ratio.

U.S. Pat. No. 6,376,558 to Bahner discloses a conventional mixer in which air is introduced under pressure through a porous fritted glass situated in the walls of the rotating mixer. In this unique mixer, the slurry is generated in a one-step process, since all components of the slurry are introduced at the same time in the mixing chamber. This device can entrain air carried into the mixer by the plaster. Furthermore, the condition for distributing the air into the slurry will vary according to the composition of the slurry, the flow rate through the mixer, and will be more variable as the mixer is worn by the slurry.

U.S. Pat. No. 2,097,088 to Mills discloses a conventional mixer for plasterboard in which air is introduced under pressure through apertures located in the bottom part of the mixer. Said mixer is said to be suited for mixing plaster and fibers. This document did not recognize the issue of the foaming agent and the foam stability, since foaming agents were not